Sustainable Priorities for Alaska Rural Communities

Hughes, Alaska

Sustainable Priorities for Alaska Rural Communities
City of Hughes
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Project management:
Alaska Native Tribal Health Consortium

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Rural Alaska Community Action Program, Inc.
Tanana Chiefs Conference

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Acknowledgements

This comprehensive energy efficiency project began in 2013 with energy audits of community buildings in Hughes, Alaska. In the following years, many people and organizations came together to perform retrofits, verify energy savings, and document the process from audit through project completion. Many thanks to the Denali Commission and the State of Alaska for providing funding for the final stages of the energy retrofit process, including energy retrofits and their documentation and the biomass boiler facilities, respectively. These organizations, their programs, and their dedicated employees help many entities in Alaska realize energy savings, through projects with outcomes that improve buildings and decrease costs for so many citizens of the state they serve. Additionally, the report authors would like to thank the following:

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Photo credits

Photos not credited in the caption were taken by members of the project team, including:

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Abstract

The Sustainable Priorities for Alaska Rural Communities (SPARC) project originated with energy audits of community buildings in Anvik and Hughes. In 2015, several agencies, led by the Alaska Native Tribal Health Consortium (ANTHC), joined to implement the recommendations from the energy audits and realize energy savings for the building occupants and owners. The Denali Commission funded energy efficiency retrofits in Hughes. This report documents the SPARC project phases in Hughes, and includes descriptions of the seven buildings that participated in the project, the recommendations in their respective audits, the retrofit construction, and the resulting energy savings.

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Acronyms

AC	Air Conditioning
ANTHC	Alaska Native Tribal Health Consortium
AVEC	Alaska Village Electric Cooperative
BTU	British Thermal Unit
CCHRC	Cold Climate Housing Research Center
CHP	Combined Heat & Power
DHW	Domestic Hot Water
ECM	Energy Conservation Measure
EEM	Energy Efficiency Measure
EOL	End of Life
°F	Degrees Fahrenheit
GCI	General Communication Inc.
HRV	Heat Recovery Ventilator
HVAC	Heating, Ventilation, and Air-Conditioning
kWh	Kilowatt-hour
LED	Light Emitting Diode
MBTU	1 Million BTUs
O&M	Operations and Maintenance
PC	Personal Computer
RurAL CAP	Rural Alaska Community Action Program, Inc.
SPARC	Sustainable Priorities for Alaska Rural Communities
TCC	Tanana Chiefs Conference
VPSO	Village Public Safety Officer
WTP	Water Treatment Plant

Motivation

The Sustainable Priorities for Alaska Rural Communities (SPARC) project aimed to advance community energy efficiency in Anvik and Hughes. The goal of the project was to implement energy efficiency improvements in those two communities. In addition, SPARC worked with a concurrent project to install district biomass heating systems in both locations. Ultimately, the outcome of the project would be lower energy use in the buildings and a resulting cost savings.

This is one of two final reports for the SPARC project. It summarizes the background, procedure, and results of the energy efficiency improvements in Hughes, Alaska. Readers will find information on the project, including the project partners and timeline, energy audit summaries, documentation of retrofit construction, and data on energy savings.

Project partners

The Alaska Native Tribal Health Consortium (ANTHC) initiated the Sustainable Priorities for Rural Alaska Communities (SPARC) project. Their Rural Energy Initiative department managed the project: collecting the energy audits, planning the retrofit construction, soliciting funding, and overseeing the retrofits and reporting. ANTHC regularly engages in energy efficiency projects to meet its mission of providing the highest quality health services for Alaska Native people. For this project, they brought together multiple partners in Alaska to complete the retrofits outlined in the energy audits, making buildings in the two rural Alaska communities of Anvik and Hughes more comfortable and reducing energy costs.

The funding for the retrofit projects came from the Denali Commission. The Commission provides critical utilities, infrastructure, and economic support throughout Alaska, encouraging energy efficiency and local energy solutions if possible in their projects. In the SPARC project, they funded the energy efficiency retrofits for the buildings, as well as covering operational project costs.

The Tanana Chiefs Conference (TCC) and Rural Alaska Community Action Program, Inc. (RurAL CAP) managed and completed the majority of the construction in both communities. TCC is a nonprofit organization, advancing tribal self-determination and regional unity among the tribes in Interior Alaska. Anvik and Hughes both lie within TCC's region. RurAL CAP is a nonprofit organization that works to improve the quality of life for low-income Alaskans. Many of their programs recognize the importance of safe, comfortable, and energy efficient buildings. They provided the weatherization crew for the SPARC project to address retrofits comprehensively during the summers of 2016 and 2017.

Alongside the SPARC project, the State of Alaska Renewable Energy Fund provided the funding for upgrades to biomass boiler facilities. The Renewable Energy Fund has a goal of bringing technically and economically-viable renewable energy projects online to decrease the reliance of Alaska communities on fossil fuels and encourage local energy solutions. The Renewable Energy Fund allowed the communities of Anvik and Hughes to switch to the local, renewable resource of biomass and decrease the amount of fuel oil they need to purchase each year during the same time period as the SPARC project.

Finally, the Cold Climate Housing Research Center (CCHRC) analyzed energy savings and authored the final project report. CCHRC promotes the development of healthy, durable, and sustainable shelter for Alaskans and other circumpolar people. CCHRC regularly participates in energy efficiency projects throughout the state.

Project timeline

The SPARC project addressed energy projects within the communities of Anvik and Hughes, both of which have leadership that recognized the importance of lowering energy use and improving buildings. After obtaining energy audits, the communities worked with ANTHC's Rural Energy Initiative department to form a plan to fund and complete the retrofits suggested by energy audits of various community buildings. SPARC officially began in July 2015 with funding from the Denali Commission to perform retrofits and monitor energy costs to identify the resulting savings. The project is nearing completion with the publication of this report, which contains a summary of each component of the project: the energy audits, retrofit construction, and energy savings.

Table 1: The SPARC project to improve the condition and energy efficiency of buildings in Hughes spanned several years.

Date	**Milestone**
June 2013	Energy audits of: City office and post office Community center Health clinic Johnny Oldman School Tribal office building Village store Washeteria & water treatment plant
July 2015	SPARC project start
2015	Installation of district biomass heating system through separate Alaska Renewable Energy Fund project
2016-2017	Retrofit construction
Fall 2018	Energy bill analysis
January 2019	SPARC project report

Project tasks

The Hughes component of the SPARC project originated with the publication of seven energy audits of community buildings in 2013. The energy audits, summarized in this report, catalogued the current condition and baseline energy usage of the buildings. They also listed recommendations for retrofits to increase the energy efficiency of each building.

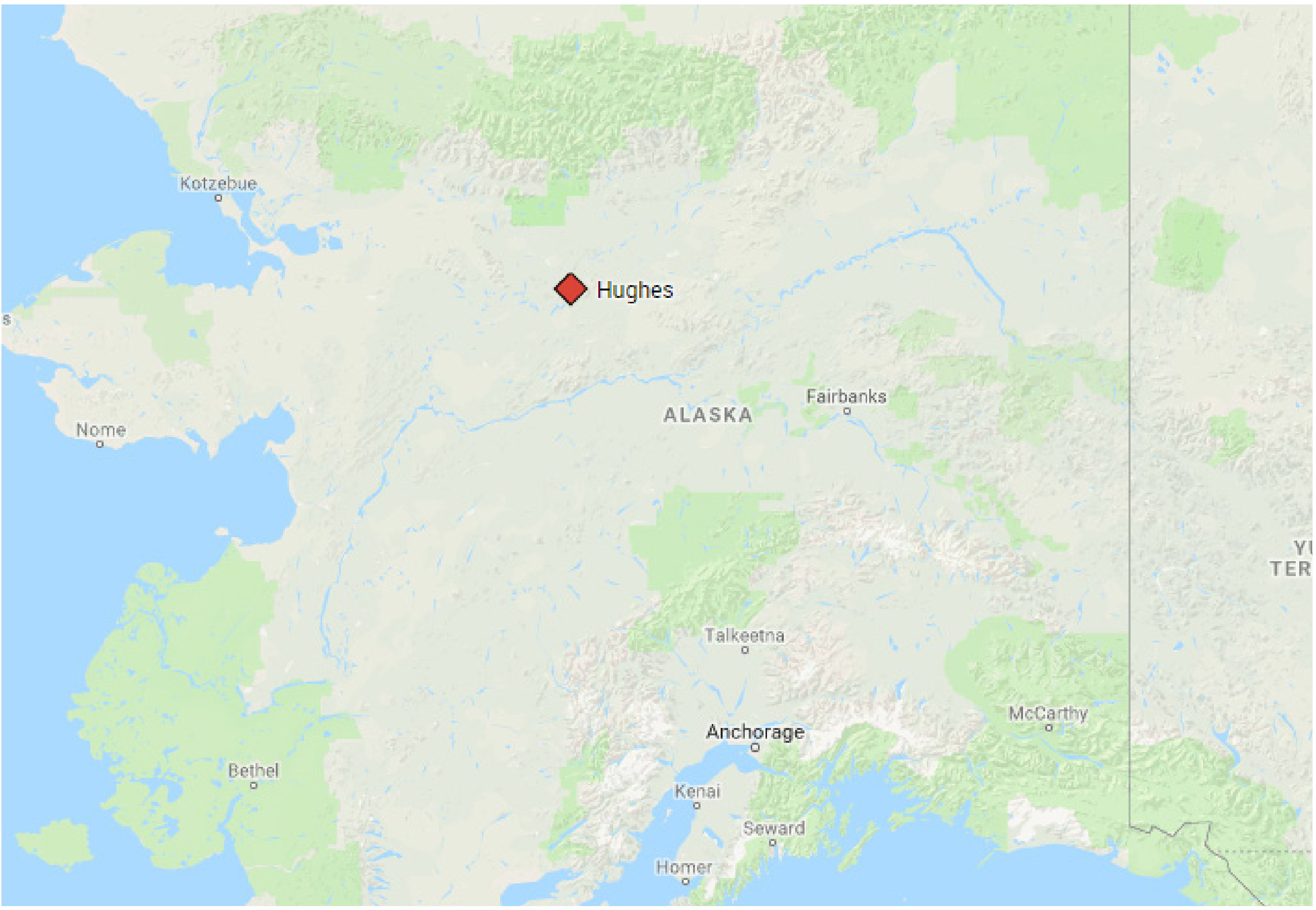


Figure 1: Hughes is located on the south bank of the Koyukuk River in Interior Alaska.

Hughes, partnering with the City of Anvik and ANTHC, obtained funding to act on the energy audit recommendations in 2015. ANTHC worked with TCC and RurAL CAP to manage and complete the various components of the construction.

At the conclusion of 2018, researchers worked with building owners to collect post-retrofit energy usage of each building from utilities and building owners. Project staff compared this data to the baseline conditions of each building to determine the energy savings that resulted from the SPARC project.

Building descriptions

Seven buildings in Hughes participated in the SPARC project. Many of them serve central roles in the community. For example, the city office and post office are frequented daily by the community, laundry services are available at the washeteria, the Johnny Oldman School provides education for local students, public well-being is supported by the health clinic, and the community center hosts weekly assemblies. In spite of this high usage, only the school and health clinic are in good condition. The building audits revealed safety issues and high energy use in several buildings. The community center raised the most concern with its deteriorating logs and damaged windows. The descriptions below, ordered alphabetically, provide details on the status of the buildings during the building audit phase of SPARC and also showcase why the buildings are important to the community.

City office and post office

The building housing the city office and post office was built in 1976 and remains in average condition, considering its age. The 2,304 square-foot, two-story log structure consists of a post office on the first floor and offices for city staff on the second floor. The building experiences high daily traffic, due to families coming to check their mail. This contributes to a large amount of infiltration from doors constantly opening and closing, despite the inclusion of an arctic entry. A single oil-fired boiler supplies heat to the building and a 60-gallon indirect hot water heater provides domestic hot water (DHW). There is no ventilation or cooling.

Figure 2: The city office and post office experiences high daily traffic, resulting in a large amount of heat loss through open doors.

Community center

The community center in Hughes was constructed in 1984 and is a 1,374 square-foot, octagonal log building with a dome roof. Community members throughout the year use this building on average of one evening per week. In the winter, the building's heater and wood stove are turned on 24 hours prior to events in order to reach reasonable comfort levels. Otherwise it is not heated. An oil burning heater and wood stove provide heat to the building, but there is no DHW, cooling, or ventilation. The building is in need of renovation as the logs are deteriorating along with the dome windows. Although the community center is minimally used, it is very important to the village.

Figure 3: The community center is used once a week, year-round, despite being in poor condition. Photo courtesy of Energy Audits of Alaska.

Figure 4: The health clinic in Hughes is relatively new, built in 2009, but has high energy and maintenance costs.

Health clinic

The 1,559 square-foot, single-story health clinic in Hughes was built in 2009. The structure contains a main office, exam room, dental room, itinerant quarters which include a kitchenette, a small lab, a morgue that is used for storage, and a behavioral health room. The building looks to be in excellent condition; however, there are several problems with the building systems resulting in high maintenance and energy costs. An oil-fired boiler supplies heat to the building and ventilation is regulated by a single HRV. There is no cooling. A 41-gallon indirect hot water heater distributes hot water to the sinks and showers.

Johnny Oldman School (Yukon Koyukuk School District)

The Johnny Oldman School was originally constructed in 1979 with additional classrooms built in 1982. The 6,200 square-foot, single-story building contains two classrooms and a gymnasium/multi-use room. Two oil-fired boilers distribute heat throughout the building, each fashioned with a series of three circulation pumps. A large exhaust fan in the gymnasium ventilates the school, and a fan coil unit provides make-up air. Within the boiler room, a 60-gallon hot water heater produces domestic hot water for sinks and showers. Despite its age, the Johnny Oldman School remains in very good condition as it is well-maintained and run very efficiently.

Figure 5: The Johnny Oldman School is well maintained and efficiently run despite its age. Photo courtesy of Energy Audits of Alaska.

Tribal office building

Built in 1993, the Tribal office in Hughes is a 1,582 square-foot, two-story building. A boiler room, lobby, and offices occupy the first floor while the second floor is made up of a kitchen, itinerant bedroom, and office. Four times a week, the kitchen is used to prepare and deliver hot meals to approximately 15 village members. An oil-fired hydronic boiler provides heat to the building and a heat exchanger provides domestic hot water, but there is no cooling. The building is in average condition considering its age.

Figure 6: The tribal office building is in average condition considering its age of 25 years. Photo courtesy of Energy Audits of Alaska.

Village store

This small building was built in 1984 with an area of 576 square feet. At the time of the SPARC retrofits in 2017, it was serving as a temporary post office instead of a store. This simple building has two doors and no windows. It does not contain plumbing, cooling, ventilation, or domestic hot water, and the building envelope has little insulation value. A Toyostove and backup electric heater provide heat.

Figure 7: The one-room village store, currently serving as a post office, lacks plumbing, ventilation, and windows. Photo courtesy of Energy Audits of Alaska.

Washeteria & water treatment plant

Constructed in 1987, the washeteria is a 1,878 square-foot, single-story building. A small area is designated as the washeteria while the water treatment plant takes up the remaining space. The building was last renovated in 2009 and remains in average condition, considering its age. Four coin-operated washing machines and three coin-operated dryers are accessible for communal use. Two oil-fired boilers supply heat and two oil-fired 100-gallon hot water heaters provide domestic hot water, however only one hot water heater remains functional. The building has high electric and oil consumption.

Figure 8: The washeteria and water treatment plant remains in average condition after a 2009 renovation. Photo courtesy of Energy Audits of Alaska.

Energy efficiency recommendations

Energy audits document a building at a moment in time, describing everything from its size and construction details to the mechanical systems to typical occupancy. Audits also document the amount of fuel and electricity the building requires for space conditioning and power. Finally, audits address how to improve the energy efficiency and safety of buildings. Each audit contains a list of recommended retrofits to a building accompanied by an estimate of their installation costs and resulting annual energy savings. The recommendations are typically ranked according to their simple payback, or the amount of time that it takes to earn back the installation price through energy savings. Low simple payback periods, indicating retrofits that are quickly cost-effective, appear at the top of the list of recommendations.

A summary of the audits performed on the buildings in Hughes in 2013 is shown in Table 2. More complete descriptions of the audit contents can be found following the table. Most audit recommendations include both energy efficiency measures (EEMs) and energy conservation measures (ECMs). EEMs are generally building and equipment upgrades that could be accomplished through a retrofit project. ECMs address methods to avoid costs by preventing excess consumption and are often suggestions for building occupants to follow to reduce energy use. The energy savings and estimated implementation costs listed in the table come directly from these audits, so do not always reflect 2019 prices accurately. Many buildings had similar recommendations, including lighting upgrades, installation of more efficient appliances, and installation and use of setback thermostats.

Table 2: The SPARC audits of Hughes community buildings recommended a variety of strategies to reduce energy use.

Building	**Audit date**	**Baseline energy use**	**Audit recom-mendations by category**	**Estimated annual fuel savings**	**Cost of implement-ing recom-mendations**	**Simple payback**
City office & post office	June 2013	Fuel oil #1: 258 MBTU Electricity: 40 MBTU Total: 298 MBTU Dollars: $25,988	Appliances Building envelope Heating system Lighting Operations & Maintenance (O&M)	$7,155 96 MBTU	$6,132	0.9 years
Community center	June 2013	Fuel oil #1: 28 MBTU Electricity: 6 MBTU Total: 34 MBTU Dollars: $3,125	Building envelope Heating system Lighting O&M	$1,520 9 MBTU	$24,143	15.9 years
Health clinic	June 2013	Fuel oil #1: 343 MBTU Electricity: 59 MBTU Total: 403 MBTU Dollars: $35,657	Appliances Building envelope Heating system Lighting O&M	$21,789 353 MBTU	$19,163	0.9 years
Johnny Old-man School	June 2013	Fuel oil #1: 515 MBTU Electricity: 73 MBTU Total: 588 MBTU Dollars: $50,234	Appliances Building envelope Heating system Lighting O&M	$8,158 151 MBTU	$10,970	1.3 years
Tribal office building	June 2013	Fuel oil #1: 133 MBTU Electricity: 26 MBTU Total: 159 MBTU Dollars: $14,483	Appliances Building envelope Heating system Lighting O&M	$6,893 71 MBTU	$51,238	7.4 years
Village store	June 2013	Fuel oil #1: 146 MBTU Electricity: 10 MBTU Total: 156 MBTU Dollars: $12,149	Building envelope Lighting Space condition-ing O&M	$5,730 48 MBTU	$12,083	2.1 years
Washeteria	June 2013	Fuel oil #1: 587 MBTU Electricity: 183 MBTU Total: 770 MBTU Dollars: $78,103	Appliances Building envelope Heating system Lighting O&M	$9,995 131 MBTU	$17,490	1.7 years

City office and post office

Audited: June 2013
Audit by: Energy Audits of Alaska

The energy audit of the city and post office building ranks re-programming existing programmable thermostats in the lobby and second floor and installing programmable thermostats in the post office and its basement as the most important measure. Addressing these heating controls is expected to be cost-effective with a fast payback period. A programmable thermostat will save energy when the spaces are not in use by setting the unoccupied setback temperature in the lobby, second floor, and post office to 60°F and the basement to 55°F. This measure would cost $402 and save approximately $2,100, paying back in less than three months. The only other EEM is to perform a lighting upgrade, replacing the exterior and front attic lighting with more efficient LED bulbs to save an approximate $16 per year and pay back in roughly three years.

Table 3: Two energy efficiency measures could result in annual savings of over $2,000 for the city office and post office.

Recommendation	**Estimated annual energy and maintenance savings**	**Estimated installation cost**	**Simple payback period (years)**
Re-program existing programmable thermostats, install (2) programmable thermostats	$2,100	$402	0.2
Upgrade exterior and front attic lighting with LED bulbs	$16	$50	3.1
2 hours for logistics: sourcing, ordering, shipping, receiving, staging		$80	
Total	$2,116	$532	0.3

The auditors also recommended several ECMs, including designating an “energy champion” to monitor building energy use and perform a monthly energy checklist walkthrough, maintaining weather stripping, turning off plug loads and using plug load management devices, reducing temperature and ventilation in un-occupied zones, scheduling lamp replacement, servicing HVAC equipment annually, and maintaining a safety inventory.

If all recommended EEMs and ECMs were performed, an estimated total of 96 MBTU in energy, or $7,155, will be saved annually.

Figure 9: Upgrading to LED bulbs in the city office attic and exterior would pay back in approximately 3 years.

Community center

Audited: June 2013
Audit by: Energy Audits of Alaska

The community center holds a strong place in hearts of many citizens of Hughes and so it will always be maintained despite its old age of 40 years. With its low use and few systems, only a few EEMs and ECMs make technical and economic sense. From an energy efficiency perspective, building renovations could not be justified and therefore lighting, doors, and windows were selected for efficiency upgrades. All three recommended measures have a comparatively high installation costs for the amount of annual energy savings they are expected to produce. Replacing the windows with triple pane windows, replacing the doors with pre-hung, insulated doors, and performing a lighting upgrade and controls upgrade will save an approximate $600 in annual energy at a total installation cost of $18,793. Together, these three EEMs will be paid back in thirty-one years.

Table 4: Three energy efficiency measures could result in annual savings of roughly $600 for the community center.

Recommendation	Estimated annual energy and maintenance savings	Estimated installation cost	Simple payback period (years)
Replace windows with triple-pane, low-e windows	$316	$12,148	38.4
Replace doors with pre-hung, insulated	$212	$4,241	20
Lighting upgrade and controls upgrade	$75	$1,604	21.4
20 hours for logistics: sourcing, ordering, shipping, receiving, staging		$800	
Total	**$603**	**$18,793**	**31.2**

The auditors also recommended several ECMs, including installing a fuel oil flow meter, designating an "energy champion" to monitor building energy use and perform a monthly energy checklist walkthrough, maintaining doors, windows, and weather stripping, scheduling lamp replacement, and servicing HVAC equipment annually.

If all recommended EEMs and ECMs were performed, an estimated total of 9 MBTU in energy, or $1,520, will be saved annually.

Health clinic

Audited: June 2013
Audit by: Energy Audits of Alaska

Figure 10: The energy audit recommended a number of retrofits for the health clinic, including programming a setback temperature on the thermostats, a lighting upgrade, and building envelope repairs.

At the time of the audit, the clinic's maintenance person stated that the building upkeep is very time-consuming and challenging. Past problems have included the waste water line freezing up and the building's high energy cost. As a result, the energy audit recommended five EEMs to decrease energy consumption. If all thermostats are programmed to an unoccupied setback temperature, an estimated $2,339 will be saved in annual energy costs and will be paid back in a year. A full lighting upgrade of replacing lamps and exterior wall packs with LEDs and adding occupancy sensors is the most expensive measure at $4,090. It is estimated that this EEM will save $504 each year in annual energy costs with a simple pay back period of eight years.

Table 5: To achieve an annual energy savings of over $18,000, auditors recommend five EEMs to be performed in the health clinic.

Recommendation	Estimated annual energy and maintenance savings	Estimated installation cost	Simple payback period (years)
Install setback thermostats in all zones	$2,339	$2,200	0.9
Lighting upgrade and controls upgrade	$504	$4,090	8.1
Shell and building envelope repairs	$4,674	$752	0.2
Replace existing ventilation control system with a programmable system, set unoccupied setbacks	$4,016	$1,000	0.2
Repair zone valve to HRV heating coil	$7,149	$1,000	0.1
50% markup for logistics: sourcing, ordering, shipping, receiving		$4,521	
Total	**$18,682**	**$13,563**	**0.7 years**

The auditor noted that the utilidor is poorly constructed and it has “joints large enough that daylight could be seen from the inside.” To combat this problem, the auditor recommended shell and building envelope repairs. If the utilidor is sealed and insulated and the bathroom’s electric space heater is removed, the building’s energy costs will decrease by $4,674. At a cost of $1,000, the installation of a programmable ventilation control system with unoccupied setbacks is expected to save roughly $4,000 in energy each year. Lastly, repairing the HRV zone valve is estimated to produce the highest energy savings at $7,149 each year.

The auditor also recommended several ECMs, including installing a fuel oil flow meter, designating an “energy champion” to monitor building energy use and perform a monthly energy checklist walkthrough, maintaining doors, windows, and weather stripping, turning off plug loads and using plug load management devices, reducing temperature and ventilation in un-occupied zones, scheduling lamp replacement, servicing HVAC equipment annually, and maintaining a safety inventory.

If all recommendations were performed, annual energy costs could decrease by $21,789.

Johnny Oldman School

Audited: June 2013
Audit by: Energy Audits of Alaska

The Johnny Oldman School is well maintained and efficiently run, but the energy audit recommends two energy efficiency measures to achieve over $2,000 in annual energy savings. Replacing eight existing manual thermostats with programmable thermostats and setting the nighttime and unoccupied temperature to 64°F will decrease the amount of energy used for heating each day. This will effectively create a total of $1,745 in estimated annual energy savings and will be paid back in under a year. Upgrading the building’s lighting to LEDs is predicted to save $689 in annual energy consumption at an installation cost of $1,980. This energy efficiency measure has a simple payback period of just less than three years.

Table 6: To achieve an annual energy savings of over $2,000, auditors recommend three EEMs to be performed in the Johnny Oldman School.

Recommendation	Estimated annual energy and maintenance savings	Estimated installation cost	Simple payback period (years)
Replace the 8 existing manual thermostats with programmable thermostats, set unoccupied temperature to 64ºF	$1,745	$1,600	0.9
Replace 2 HPS-150w wall packs and entry lights with LEDs	$689	$1,980	2.9
50% for logistics: sourcing, ordering, shipping, receiving, staging, etc.		$1,790	
Total	**$2,434**	**$5,370**	**2.2**

The auditors also recommended several ECMs, including installing a fuel oil flow meter, designating an "energy champion" to monitor building energy use and perform a monthly energy checklist walkthrough, maintaining doors, windows, and weather stripping, turning off plug loads and using plug load management devices, reducing temperature and ventilation in unoccupied zones, scheduling lamp replacement, servicing HVAC equipment annually, and maintaining a safety inventory.

If all recommended EEMs and ECMs were performed, an estimated total of 151 MBTU in energy, or $8,158, will be saved annually.

Tribal office building

Audited: June 2013
Audit by: Energy Audits of Alaska

The tribal office is in average condition but required an adjusted baseline energy calculation during the energy audit because existing conditions were unrepresentative of a sustainable baseline energy consumption. The auditor first corrected the unsafe and unacceptable conditions and then calculated the consumption and savings for the "adjusted baseline" conditions. The EEM with highest priority is programming the thermostats to an unoccupied setback temperature of 64°F within the kitchen, second floor office, and the second floor itinerant quarters. This measure is expected to save approximately $400 and is easy to implement. The next measure in priority was to perform a lighting and controls upgrade. At an installation cost of roughly $4,000, this EEM is estimated to achieve $661 in energy savings each year. Upgrading the building envelope and insulation is expected to reach an annual energy savings of $1,623. Installing insulation with higher R-values in the walls and ceiling will create a higher resistance to heat flow exiting the building, thus decreasing fuel consumption. Lastly, by replacing the desktop PCs with laptops at an installation cost of about $600, will result in an annual energy savings of $547.

Table 7: Five energy efficiency measures could yield annual savings of roughly $3,000.

Recommendation	**Estimated annual energy and maintenance savings**	**Estimated installation cost**	**Simple payback period (years)**
Retrofit setback thermostats in all appropriate zones	$393	$3	0
Lighting upgrade and controls upgrade	$661	$2,949	4.5
Envelope and insulation upgrades; add R-10 to walls, add R-33 to ceiling	$1,623	$38,885	24
Desktop PC replaced with Laptops at EOL	$547	$601	1.1
80 hours for logistics: sourcing, ordering, shipping, receiving, staging		$3,200	
Total	**$3,224**	**$45,638**	**14.2 years**

The auditors also recommended several ECMs, including installing a fuel oil flow meter, designating an "energy champion" to monitor building energy use and perform a monthly energy checklist walkthrough, maintaining doors, windows, and weather stripping, turning off plug loads and using plug load management devices, reducing temperature and ventilation in un-occupied zones, scheduling lamp replacement, servicing HVAC equipment annually, and maintaining a safety inventory.

If all recommended EEMs and ECMs were performed, an estimated total of 71 MBTU in energy, or $6,893, will be saved annually.

Village store

Audited: June 2013
Audit by: Energy Audits of Alaska

Because there are no comparative buildings to the single purpose village store, there is little to be recommended regarding energy efficiency improvements that do not involve the building's envelope. Despite its poor insulation value, renovations are not cost effective from an energy perspective. The auditors still recommend three energy efficiency measures to reduce annual energy costs. At the top of the priority list, with virtually no cost, is programming the setback thermostat on the Toyostove to 60°F to achieve an estimated annual energy savings of $1,598. By performing a lighting upgrade of replacing the exterior lighting with more efficient LED bulbs, an energy savings of $60 per year is expected. Lastly, construction of an arctic entry on the front of the building is recommended to reduce air infiltration and save $2,427 in annual energy costs. This measure will cost $4,600 with a simple pay back period of roughly two years.

Table 8: The village store could achieve an annual savings of $4,085 if three energy efficiency measures are implemented.

Recommendation	Estimated annual energy and maintenance savings	Estimated installation cost	Simple payback period (years)
Program the setback thermostat on Toyostove Laser 73	$1,598	$5	0
Exterior Lighting: replace compact fluorescent light and incandescent bulbs with LEDs	$60	$50	0.8
Construct an arctic entry on front of building	$2,427	$4,600	1.9
50% markup for logistics: sourc-ing, ordering, shipping, receiving, staging		$2,328	
Total	**$4,085**	**$6,983**	**1.7 years**

The auditors also recommended three ECMs, including installing a cumulative fuel oil flow meter, designating an “energy champion” to monitor building energy use and perform a monthly energy checklist walkthrough, and maintaining weather stripping.

If all recommended EEMs and ECMs were performed, an estimated total of 48 MBTU in energy, or $5,730, will be saved annually.

Washeteria & water treatment plant

Audited: June 2013
Audit by: Energy Audits of Alaska

The washeteria underwent upgrades as recently as 2009 and remains in average condition. The oil and electric consumption for this building are reported to be very high, and the auditors recommend a few EEMs to reduce the energy costs. Many community members rely on the washeteria for laundry services, so implementing three energy efficiency measures in this building will be quickly noticed. Of these recommended EEMs, highest priority goes to replacing the manual thermostats with programmable thermostats and setting the unoccupied setback temperature to 64°F in the washeteria and 55°F in the water treatment plant. Programmable thermostats will save $251 in energy when spaces within the building are not in use. Second in priority is replacing the existing non-functional occupancy sensors and replacing the entry light with an LED light fixture. This measure will generate an estimated $724 in annual energy savings toward lighting with a payback period of less than a year. Lastly, replacing the streetlights and pole fixtures with LED fixtures will result in over $2,000 in annual energy savings. Replacements for the streetlights are on hand in storage and just need to be installed, while installing four new LED pole fixtures will cost upwards of $7,000.

Table 9. The washeteria could achieve an annual savings of more than $3,000 if three energy efficiency measures are implemented.

Recommendation	Estimated annual energy and maintenance savings	Estimated installation cost	Simple payback period (years)
Install programmable thermostats and set unoccupied temperature to 64°F in washeteria and 55°F in WTP	$251	$400	1.6
Replace existing non-functional occupancy sensors	$724	$601	0.8
Replace streetlights and pole fixtures with LED fixtures	$2,274	$7,492	
40% markup for logistics: sourcing, ordering, shipping, receiving, staging		$3,397	
Total	**$3,349**	**$11,890**	**3.6 years**

The auditors also recommended several ECMs, including designating an “energy champion” to monitor building energy use and perform a monthly energy checklist walkthrough, maintaining doors, windows, and weather stripping, turning off plug loads and using plug load management devices, reducing temperature and ventilation in un-occupied zones, scheduling lamp replacement, servicing HVAC equipment annually, and maintaining a safety inventory.

If all recommended EEMs and ECMs were performed, an estimated total of 131 MBTU in energy, or $9,995, will be saved annually.

Figure 11: Installing and using programmable thermostats in the washeteria would pay back in less than 2 years.

Construction documentation

In September 2016, RurAL CAP completed a scope assessment, reviewing the energy audits and noting changes to the buildings that had occurred post-audit. This allowed them to slightly modify the scope of work from the original audits to reflect the current conditions of the buildings. RurAL CAP's weatherization crew began retrofit work that same fall, and another crew came back to finish the majority of the work in Spring 2017. The weatherization crew was able to retrofit all of the audited buildings in Hughes with the exception of the village store, a small one-room building. The majority of the retrofits involved installing programmable thermostats, upgrading lighting to LED bulbs, and a blower door-guided air-sealing effort. However, as noted in the tables for each building, the crew also completed many retrofit tasks specific to certain buildings.

With separate funding from the state of Alaska, Hughes received a biomass district heating system. TCC, contracting Jim Chowaniec, commissioned the system in late 2015. It is currently providing heat to three buildings, the city and post office building, the school, and the washeteria & water treatment plant building.

In this section, the tables underneath each building list the completed scope of work. The completed tasks are divided into those included in the audit recommendations, and those that were added to the scope of work during the retrofit effort.

City office and post office

RurAL CAP completed all of the audit recommendations for the city office and post office building in 2016 and 2017. In addition, the weatherization crew installed smoke alarms and carbon monoxide detectors in Spring 2017.

Table 10: RurAL CAP completed all audit recommendations for the city office building.

Completed audit recommendations	Date completed	Contractor	Notes
Re-program existing programmable thermostats, install (2) programmable thermostats	Fall 2016	RurAL CAP	
Upgrade exterior and front attic lighting with LED bulbs	Fall 2016 and Spring 2017	RurAL CAP	In 2016, RurAL CAP installed LED 10-Watt wall packs. In 2017, they installed LED 10-Watt A-lamps.
Weather-stripping installation	Spring 2017	RurAL CAP	The crew completed a blower door-guided air-sealing that included: • installing door sweeps.
Annual HVAC equipment service	Spring 2017	RurAL CAP	The crew installed a bath fan as part of ventilation servicing.
Additional work			
Air-seal and insulate the attic	Spring 2017	RurAL CAP	
Install smoke alarms and carbon monoxide detectors	Spring 2017	RurAL CAP	

Community center

In 2016 and 2017, the weatherization crew was able to address many of the audit recommendations for the community center in Hughes, including changing lighting to LEDs, installing pre-hung insulated doors, and air sealing the building.

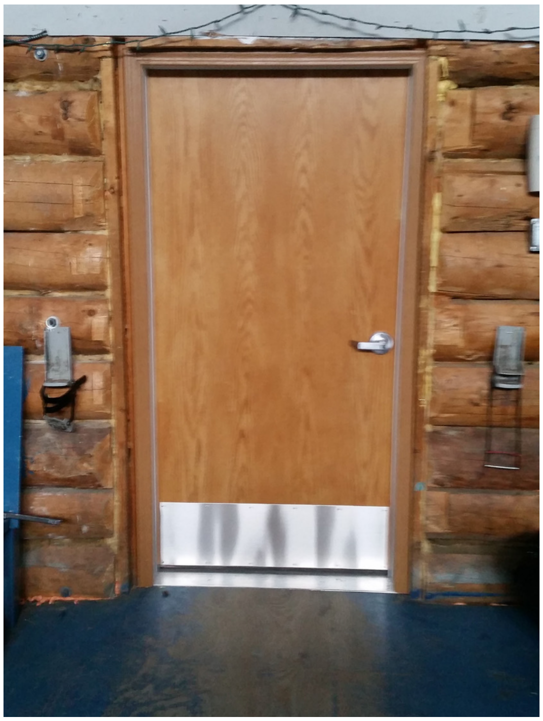


Figure 12: The community center's retrofit included two new doors.

Table 11: The community center received a lighting upgrade, new doors, and air-sealing during a retrofit.

Completed audit recommendations	Date completed	Contractor	Notes
Replace doors with pre-hung, insulated versions	Spring 2017	RurAL CAP	
Lighting upgrade and controls upgrade	Fall 2016 and Spring 2017	RurAL CAP	
Weather stripping installation & maintenance	Spring 2017	RurAL CAP	The crew completed air sealing following a blower door test.

Health clinic

The health clinic in Hughes received programmable thermostats and new lighting during two visits from RurAL CAP. The crew also completed air-sealing on the building envelope, and was able to further assess and troubleshoot the HVAC equipment.

Table 12: Retrofit work on the health clinic included a lighting upgrade and programmable thermostats.

Completed audit recommendations	Date completed	Contractor	Notes
Retrofit setback thermostats in all zones	Fall 2016 & Spring 2017	RurAL CAP	
Lighting upgrade and controls upgrade	Fall 2016 & Spring 2017	RurAL CAP	
Weather stripping installation	Spring 2017	RurAL CAP	The crew completed a blower door-guided air-sealing that included: • Adding door sweeps and weather-stripping.
Annual HVAC equipment service	Spring 2017	RurAL CAP	The crew assessed the heating system and made recommendations for its improvement.

Figure 13: Many buildings, including the clinic, received programmable thermostats through the SPARC project.

Johnny Oldman School

The Yukon-Koyukuk School District (YKSD) completed nearly all audit recommendations on the Johnny Oldman School during the summer of 2016.

Table 13: YKSD peformed a comprehensive retrofit on Johnny Oldman School in 2016.

Completed audit recommendations	Date completed	Contractor	Notes
Replace the 8 existing manual thermostats with programmable thermostats, set unoccupied temperature to 64ºF	Summer 2016	Yukon-Koyukuk School District	Replaced 5 thermostats in the main building.
Replace 2 HPS-150w wall packs and entry lights with LEDs	Summer 2016	YKSD	Included installation of occupancy sensors throughout the building.
Weather stripping installation	Summer 2016	YKSD	The crew completed air-sealing that included: • Caulking around the windows, • Weather stripping around doors, • Adjusting door sills and catch plates to allow for a tighter fit, • Replacing the exterior door and jamb in the North gym, • Replacing the jamb on the sprinkler room door, and • Replacing the boiler room door and jamb.
Annual HVAC equipment service	Summer 2016	YKSD	The crew insulated the 2-inch heating supply line.

Tribal office building

RurAL CAP completed work on the tribal office building in 2016 and 2017. The crew addressed two of the main audit recommendations, to upgrade the lighting and to install programmable thermostats in the building. They also performed air-sealing on the building envelope and installed a new bath fan. Finally, to improve building safety, the crew also installed smoke alarms and carbon monoxide detectors in Spring 2017.

Table 14: The tribal office building received upgrades in 2016 and 2017.

Completed audit recommendations	Date completed	Contractor	Notes
Retrofit setback thermostats in all appropriate zones	Fall 2016	RurAL CAP	
Lighting and controls upgrade	Fall 2016 & Spring 2017	RurAL CAP	The crew also intalled occupancy sensors.
Weather stripping installation	Spring 2016	RurAL CAP	The crew completed a blower door-guided air-sealing that included: • Adding door sweeps.
Additional work			
Air-seal and insulate the attic	Spring 2016	RurAL CAP	
Install new bath fan	Spring 2016	RurAL CAP	
Install smoke alarm and carbon monoxide detector	Spring 2017	RurAL CAP	

Village store

The weatherization crew did not retrofit the village store, a one-room building that houses goods for purchase. At the time of the retrofits, the store was serving as a temporary post office, and its future use and occupancy were not known.

Washeteria & water treatment plant

In spring 2017, RurAL CAP's weatherization crew addressed all of the audit recommendations for the washeteria. This included upgrading lighting, replacing occupancy sensors, and installing programmable thermostats.

Table 15: RurAL CAP addressed all audit recommendations for the washeteria in Spring 2017.

Completed audit recommendations	Date completed	Contractor	Notes
Install programmable thermostats and set unoccupied temperature to 64°F in washeteria and 55°F in WTP	Spring 2017	RurAL CAP	RurAL CAP contracted the YKSD electrician to complete the retrofit.
Replace existing non-funcitonal occupancy sensors and upgrading lighting to LED bulbs	Spring 2017	RurAL CAP	
Replace streetlights and pole fixtures with LED fixtures	Unknown	Unknown	This task had already been completed when the RurAL CAP crew arrived in 2017.
Weather-stripping installation	Spring 2017	RurAL CAP	The crew completed a blower door-guided air-sealing that included: • Adding a door sweeps, and • Replacing window hardware.
Annual HVAC equipment service	Spring 2017	RurAL CAP	The crew installed a bath fan.

Figure 14: Retrofits to the washeteria and water treatment plant included LED lighting and a bath fan.

Biomass integration project

With separate funds from the state of Alaska, Hughes received a district biomass heating system. The system provides heat to the city and post office building, the school, and the washeteria and water treatment plant building. TCC, contracting Jim Chowaniec, installed the district heating loop in 2015. Since it was commissioned, it has used between 30 and 50 cords of wood per year of local wood harvest and driftwood. The Tribe purchases the cordwood from community members, and employs one part-time operator to run the system (Devany Plentovich, personal communication, January 17, 2019).

Figure 15: Two cordwood boilers (above left) are helping to lower energy costs in Hughes by using local wood harvest (above right) to provide heat to several buildings in the community. Photos courtesy of Devany Plentovich.

Additional work

In addition to the energy efficiency work completed on the community buildings with energy audits, leftover SPARC funds were used to improve other buildings in Hughes. In the summer of 2018, the Alaska Native Renewable Industries completed a residential LED lighting retrofit of 39 homes in Hughes. Each home received a lighting audit, new bulb installation, and old bulb disposal.

Further, the SPARC project included a lighting upgrade for the street lights to LED bulbs. The auditor included this with the washeteria audit, as noted in the table in that section. However, we include it here as well to note that it was not specific to any one building.

Energy savings

The purpose of an energy retrofit is to decrease a building's energy use while improving the safety and comfort. An important check on whether or not the audit and retrofit process worked as intended is see whether the energy use dropped as predicted. This section reports on the pre- and post-retrofit energy usage obtained for many of the buildings in the SPARC project in the units in which it is typically purchased: electric usage is reported in kilowatt-hours (kWh) and fuel usage is reported in gallons of fuel.

The baseline energy usage, or pre-retrofit energy use, comes from the energy audits, which typically contain an estimate of the building's energy use either from fuel records that the auditor was able to access, or from the energy model of the building. The report authors gathered the post energy use with help from building occupants. Unfortunately, authors were unable to obtain energy use information for the health clinic, tribal office building, or the washeteria and water treatment plant building. Of the remaining buildings, the city office and post office building saw electrical energy use decrease after the energy efficiency retrofit. The community center's electrical energy use remained steady. The Johnny Oldman School experienced an increase in energy needs; however, this corresponded with an increase in the use and occupancy of the building. These are only initial reports. For more a more accurate understanding of the energy saving effects of the EEMs installed in Hughes, a longer reporting period is recommended. It's also important to note that Hughes was separately completing significant leveling projects at the City Office and the Tribal office during some of the performance period that could contribute to additional electrical consumption.

City office and post office

The city office and post office building used an average of 7,650 kWh per year before the retrofits, and an estimated 5,500 kWh per year ending after the retrofit. This amounts to a pre-retrofit to post-retrofit savings of 2,150 kWh each year, nearly a one third decrease.

The post-retrofit electrical data included bills from January through October 2018. In order to arrive on the yearly figure shown in Figure 16 below, staff assumed the November and December 2018 usage as identical to January 2018 usage. The reason for this assumption, rather than using an average use from all months, is that electrical needs tend to be higher in winter when Alaska experiences less sunlight and colder temperatures.

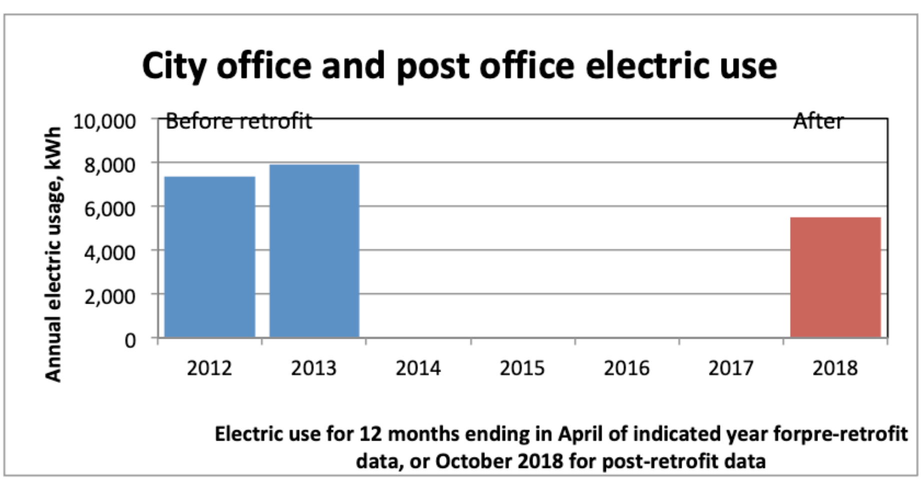
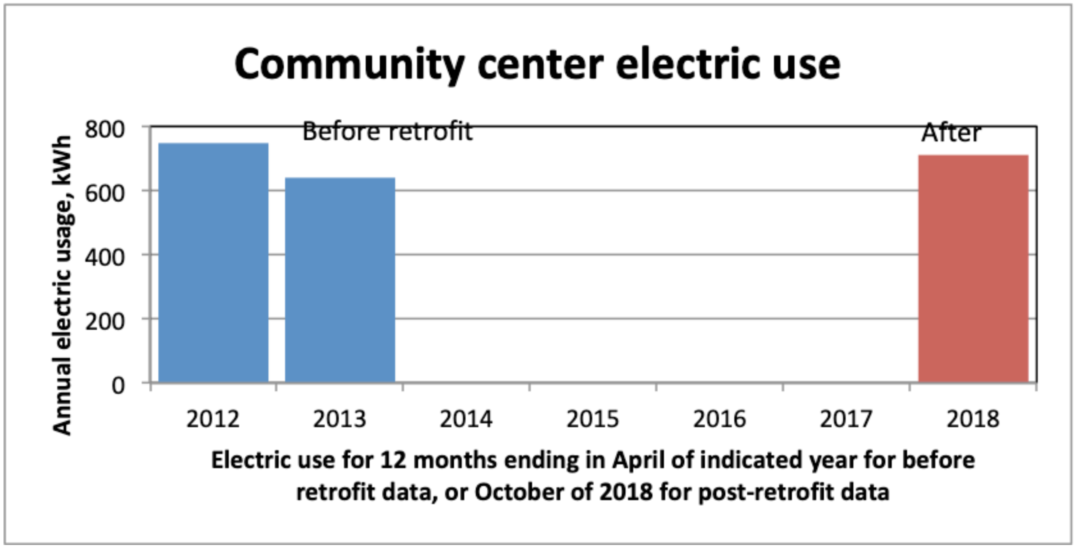


Figure 16: The office building's electrical energy use decreased after a retrofit that included a lighting upgrade.

Community center

Similar to the city office and post office, authors received only ten months of post-retrofit electrical data for the community center. The yearly total was estimated in the same fashion as for the city and post office, by assuming that November and December 2018 usage was identical to January 2018 usage. With this assumption, the pre-retrofit electric usage of approximately 700 kWh per year was nearly identical to the 711 kWh usage after the retrofit.

Figure 17: The community center's electrical energy remained steady after a lighting upgrade.

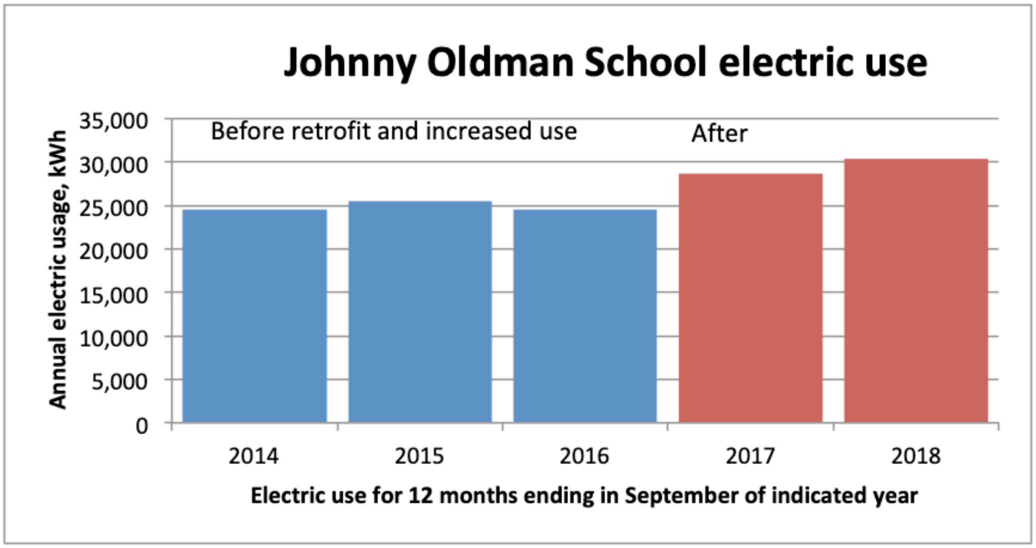


Johnny Oldman School

The effects of the retrofit at the Johnny Oldman School are hard to quantify, as the school building use increased during 2016 and 2017, the same time period as the building retfofit. The school started offering more after-school clubs to the students and, more importantly, started serving breakfast and lunch to students, using 4 freezers and 3 refrigerators to store 3-4 weeks of food at a time. Prior to this change, the kitchen only required the use of one refrigerator and one freezer. Furthermore, the extra food preparation requires additional use of other kitchen appliances, all of which are electric. Finally, the student population has roughly doubled in the past 5 years to nearly 20 students (Patty White, off site principal, personal communication, January 22, 2019).

With this change in building use, the energy and fuel usage for Johnny Oldman School increased, despite the energy efficiency retrofit. The annual electric usage ending in September 2014 and 2015 was on average 25,000 kWh. The annual usage for the twelve months ending in September 2017 and 2018 was on average 29,500 kWh, an increase of approximately 4,500 kWh from pre-retrofit period (18%).

The fuel usage in the school has also increased from the pre-retrofit period to that after the retrofit. The data provided included readings of fuel levels several times a year and some deliveries. Other deliveries were estimated when fuel levels increased from one reading to the next. Since there was often a reading at the end of the school year, the annual usage was estimated from the end of May of one year to the next. For example, 2014 data shows the data from June 2013 through May 30, 2014 (or the closest May reading to either date).



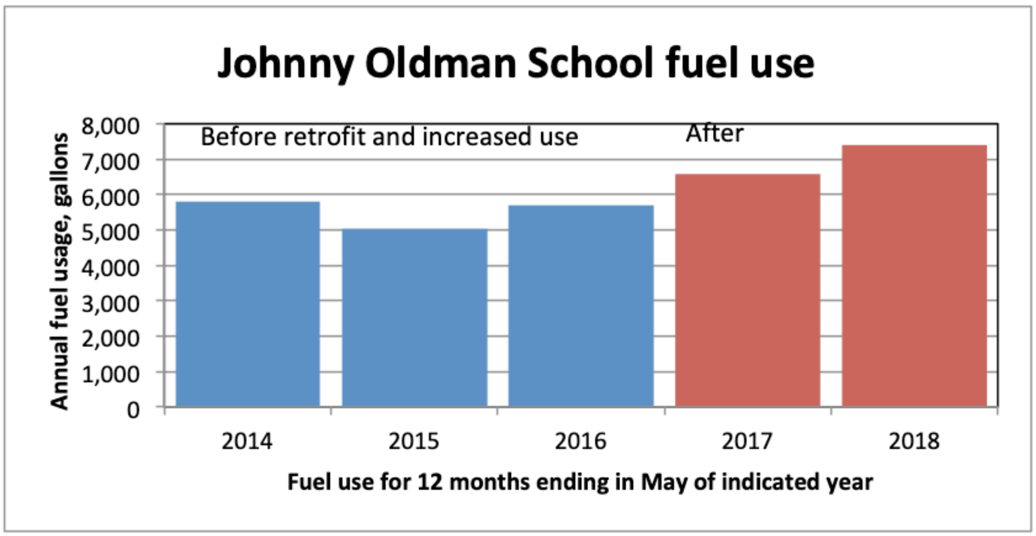


Figure 18: The energy use of the school increased after the building's occupancy and hours of operation increased, in spite of energy efficiency retrofit work in 2016.

The average pre-retrofit (2014-2016) fuel usage for the Johhny Oldman School was 5,500 gallons of fuel used per year. On average, the post-retrofit fuel usage is 6,990 gallons of fuel each year. This amounts to an increase of 1,485 gallons, or nearly a quarter higher post-retrofit than pre-retrofit. The increased fuel usage is likely due to an increase in the number of hours the school building is used.

Conclusion

The SPARC project goal was to improve community buildings in rural Alaska and create energy savings for residents. SPARC was a comprehensive retrofit project, achieving energy efficiency improvements alongside the commissioning of biomass heating systems in the two Alaska communities of Anvik and Hughes. Beginning with energy audits of community buildings, SPARC project leaders and staff identified and secured funding from the Denali Commission and the State of Alaska to complete the audit recommendations. Construction crews, led by the Tanana Chiefs Conference and RurAL CAP, implemented the majority of the audit recommendations and installed a district biomass heating system in both communities in 2016-2017. The final year of the project, 2018, was dedicated to documenting the project procedure and verifying energy savings resulting from the retrofits.

In Hughes, seven buildings received energy audits prior to 2015. These buildings, all central to community needs and events, serve the majority of the village's population. The SPARC construction crew implemented energy efficiency retrofits in six of these buildings, as well as connecting three of the buildings to a district biomass heating system operated by the Tribe. Authors were able to verify a reduction in energy use in only one building; however, a second building's energy use remained steady. The Johnny Oldman School saw an increase in energy use, but this corresponds to an increase in the occupancy and hours of operation of the building, along with staff offering additional services.

Alaska's cold climate too often results in high energy costs and uncomfortable buildings. Energy audits are a useful tool for pointing the way toward energy savings; however, the energy audit recommendations must be implemented for energy use to decrease. The SPARC project, in addition to improving buildings and reducing energy costs in Anvik and Hughes, has also provided a template for how such a community energy project can occur, and, for some participating buildings, a verification of the energy savings predictions from energy audits. It also serves as an important example of how community leadership and motivation, as well as agency cooperation, can result in better buildings, lower costs, and more resilent communities.